

SECTION 02300

EARTHWORK

PART 1 - GENERAL

0.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the following items.

1. Preparing subgrades for buildings, structures and landscaping
2. Excavating, backfilling and compacting for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Subbase course for bituminous and cement concrete pavements.
5. Subsurface drainage backfill for walls and trenches.
6. Excavating, backfilling and compacting for utility trenches.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 02100 - SITE PREPARATION; temporary erosion and sedimentation control measures, site stripping, grubbing, stripping and stockpiling topsoil, and removal of above and below-grade improvements and utilities.
2. Section 02221 - DEMOLITION; removal of hazardous materials and underground storage tank removal.
3. Section 02240 - DEWATERING; dewatering activities.
4. Section 02260 - EXCAVATION SUPPORT AND PROTECTION; shoring and bracing.
5. Section 02282 - HANDLING, TRANSPORTATION AND DISPOSAL OF EXCAVATED MATERIAL; definitions of material.
6. Section 02920 - LAWNS; finish grading, including preparing and placing topsoil and planting soil for lawns.
7. Section 03300 - CAST-IN-PLACE CONCRETE; granular course if placed over vapor retarder and beneath the slab-on-grade.
8. Divisions 2, 15, and 16 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.

0.2 UNIT PRICES

A. Rock Measurement: Volume of rock actually removed to the limits indicated in the Contract Documents measured in its original position. Payment includes, but is not limited to replacement with approved materials and disposal of excess rock.

0.3 DEFINITIONS

- A. Backfill:** Soil and/or fill material and/or controlled low-strength material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside the pipe from the springline to the crown of the pipe or utility and 12-in over pipe or utility in a trench unless otherwise noted, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to approximate the gravel sub-base layer (12-in plus the thickness of the bituminous or cement concrete final surface) to fill a trench.
- B. Bedding Course:** Granular material placed under structures or utilities to a depth of 12-in unless otherwise noted and to the springline of the pipe or utility or to the base of the structure.
- C. Borrow:** Geotechnically and analytically satisfactory soil imported from off-site for use as fill or backfill.
- D. Drainage Course:** Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- E. Excavation:** Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices. Also called overexcavation.
 - 2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
 - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.
- F. Fill:** Soil materials used to raise existing grades. Fill (Urban Fill): In-situ material known as Fill, also known as urban fill or miscellaneous fill, is defined as a mixture of soil and other materials which have been located in the area through man-made processes primarily for the purpose of grading, backfilling or filling in low areas. Material commonly associated with urban fill includes, but are not limited to; glass, brick, ash, wood fragments and other similar granular materials. Urban fill shall not include boulders, ledge, consolidated rock, asphalt, concrete, railroad timbers, rail, cobblestones or any other abandoned building materials which would preclude the disposal of the urban fill as daily cover at a landfill. Material containing less than 10%, by volume, solid waste/debris, as determined by the Engineer, shall be classified as urban fill. Material that contains 10%

or more solid waste/debris by volume, as determined by the Engineer, shall be classified as solid waste.

- G.** Soil (Natural Soils): Soil, otherwise known as natural soil, is defined for the purposes of the Contract as unconsolidated sand, gravel, silt and clay, and the organic material which has become part of the unconsolidated soil matrix.
- H.** Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
- I.** Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, manholes, catch basins or other man-made stationary features constructed above or below the ground surface.
- J.** Subbase Course: Course placed between the final backfill and the bituminous or cement concrete pavement.
- K.** Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- L.** Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

0.4 Quality Assurance

- A.** The Authority reserves the right to perform inspections and testing at any time during the execution of work.
- B.** When rework or replacement of soils are required to achieve compaction, the Authority will conduct confirmatory testing.

0.5 Quality Control

- A.** The Contractor shall assume full responsibility for control inspection and testing and give sufficient notice to the Engineer to permit the witnessing of the inspections or tests.
- B.** The contractor shall engage a qualified, independent testing agency to perform quality control testing and inspections.

0.6 SUBMITTALS

A. Product Data: For the following:

1. Geotextile.
2. Controlled low-strength material, including design mixture.

B. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site and borrow soil and/or fill material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D 1557 for each onsite and borrow soil and/or fill material proposed for fill and backfill.
3. During Construction, submit written confirmation of fill lift thickness, in-place soil moisture content, and percentage of compaction to the Engineer before placing the next lift or constructing foundations.

C. Qualifications for Approving Source: Prior to earthwork operations, submit the qualifications of the persons or Agency approving the source of supply of materials and control testing and inspection.

D. Hold Point-Earthwork Operations: Submit, prior to the excavation of earthwork activities, a plan describing the earthwork operations including the frequency and locations of tests and inspections. No work shall be performed until this plan has been approved by the Engineer.

E. Hold Point-Supply and Control Inspection Results: Submit the results of all sources of supply and control inspections and tests. Submittals reviewed beyond the second rejection (or required submittal) shall be provided at no cost to the Authority and shall be reviewed by the Engineer at the Contractor's expense. No work shall be performed until the Engineer has approved the source of supply.

F. Hold Point-Material Handling: At least two weeks prior to the start of any excavation activity submit, in writing, the following for review and shall not start excavation activity until the entire submittal is acceptable to the Engineer.

1. Description of the method of dewatering excavated material and control of effluent water quality.
2. Identification of a licensed hauler and disposal facility for possible vacuum collection, trucking and disposal of contaminated aqueous liquids.
3. Locations and methods of excavating, handling, and stockpiling (if applicable) excavated material, including drainage, as specified in this Section. Describe methods to keep materials from various sources separated during stockpiling operations (if applicable).

- G.** Preexcavation Photographs and Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins. Maintain catalog of up-to-date photographs at the site.
- H.** Backfill Materials: Submit a 20 lb. sample, grain size analysis and moisture density curve performed in accordance with ASTM D422 and compaction test results (ASTM D1557 Procedure C) for each proposed source of backfill, imported material and on-site material to be reused, for review by the Engineer at least, one (1) week prior to use of the material. The grain size analysis shall indicate that the backfill material conforms to the gradation requirements specified.
- I.** In addition, a certification statement and analytical results shall accompany each physical sample of earth materials to be imported onto the site, including but not limited to crushed stone, loam, bedding sand, gravel sub-base, common fill and structural backfill. At a minimum the certification shall state the point of origin and that the material is free of contaminants. The certification shall include representative sample analysis from each point of origin of backfill to be used on the site. The sample(s) shall be analyzed by a certified laboratory for total metals (EPA priority pollutant metals), volatile organic compounds (EPA Method 8260), semi-volatile organic compounds (EPA Method 8270), petroleum hydrocarbons (EPA Method 8100), and Total PCBs and pesticides (EPA Method 8081 and 8082). On-site soils defined as suitable for reuse in this Section and in Section 02080 - SOIL AND WASTE MANAGEMENT can be used as backfill without providing the certification required above.
- J.** All sampling of soils for chemical testing shall be performed by a person experienced in sample collection and shall be either: 1) a Licensed Site Professional registered in the Commonwealth of Massachusetts; 2) a Professional Engineer registered in the Commonwealth of Massachusetts; 3) a professional Geologist registered in the Commonwealth of Massachusetts; 4) a certified groundwater/environmental professional; or 5) an authorized representative of the one of the persons listed above. Samples of each material shall be submitted to a chemical analytical laboratory, certified by the Massachusetts Department of Environmental Protection.
- K.** Submit additional samples and geotechnical and analytical test data and certifications for every 1000 cubic yards (every 200 cubic yards for moisture density curves) of material imported or reused on-site or anytime consistency of material changes in the opinion of the Engineer. Submit associated chemical laboratory data on the imported materials throughout the course of the Work, if requested by the Engineer, to evaluate the consistency of the source or process, at no additional cost to the Owner.

0.7 PROJECT CONDITIONS

- A.** Existing Utilities: Do not interrupt utilities serving facilities occupied by the Authority or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.
1. Notify the Engineer not less than two days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without the Engineer's written permission.
 3. Contact utility-locator service for area where Project is located before excavating.
- B.** Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

1.6 QUALITY ASSURANCE

- A.** The Engineer will establish which tests are necessary to determine compliance with these Specifications.

PART 2 - PRODUCTS

0.1 SOIL MATERIALS

- A.** Soil, Fill and Borrow Materials:

1. Ordinary Borrow: M1.01. with the following gradation requirement.

Sieve Size	Percent	Passing	by
<u>Weight</u>			
4-inch (102 mm)	100		
No. 200	0-20		

2. Gravel Borrow: M1.03.0 with the following gradation requirement.

Sieve Size	Percent	Passing	by
<u>Weight</u>			
3-inch (76.2 mm)	100		
1/2 inch (12.5 mm)	50-85		
No. 4	40-75		
No. 50	8-28		
No. 200	0-10		

3. Processed Gravel for Subbase: MHD M1.03.1.
4. Sand Borrow: Sand borrow shall be used as pipe bedding for all pipe with the exception of Reinforced Concrete Pipe, placed between 6 inches below pipe invert to 6 inches above pipe crown

5. Sand Borrow for Subdrains: MHD M1.04.1.
6. Controlled Density Fill (CDF): Controlled density fill shall consist of a cementitious hard excavatable mixture of aggregate, Portland Cement, air entraining admixtures and water. The material shall be of the type specified in Massachusetts Highway Department 1995 Standard Specifications for Highway and Bridges, Type 2E. Controlled density fill shall be used as trench backfill material around structures (not including manholes and catch basins) between the top of the crushed stone layer and the top of the structure. Controlled density fill shall also be used to fill abandoned utilities and around the excavation support systems as directed by the Engineer.

B. Aggregates and Related Materials:

1. Crushed Stone: gradation as follows: Dense graded crushed stone for sub-base, Crushed stone shall be used as Reinforced Concrete Pipe bedding between 6 inches below pipe invert to 6 inches above pipe crown and initial 12 inches of backfill under structures, as a working mat or as a filter around perforated drain pipe. Crushed stone shall be wrapped in filter fabric, placed in maximum 6-inch thick layers, loose measure, and compacted with a minimum of four passes of a vibratory plate or roller compactor. The crushed stone shall be uniformly blended.

C. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

D. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

E. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

- H.** Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.
- I.** Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.
- J.** Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.
- K.** Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

0.2 GEOTEXTILES

- A.** Geotextiles: {Designer to add site specific requirements} e.

PART 3 - EXECUTION

0.1 PREPARATION

- A.** Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B.** Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Section 02100 - SITE PREPARATION.
- C.** Protect and maintain erosion and sedimentation controls, which are specified in Section 02100 - SITE PREPARATION, during earthwork operations.
- D.** Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

0.2 DEWATERING

- A.** Comply with requirements of Section 02240 - DEWATERING.

0.3 EXPLOSIVES

- A.** Explosives: Do not use explosives. Use of explosives is subject to consideration by the Authority only on a case-by-case basis.

0.4 EXCAVATION, GENERAL

- A.** Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include bituminous and cement concrete sidewalks and roadways, bricks and cobbles, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
 2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
 - a. 24 inches outside of concrete forms other than at footings.
 - b. 12 inches outside of concrete forms at footings.
 - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 - e. 12 inches beneath bottom of concrete slabs on grade.
 - f. 12 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

0.5 EXCAVATION FOR STRUCTURES

- A.** Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch if applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work. If material remaining at bottom of trench is disturbed, recompaction shall be required.
 2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
 3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces. If material remaining at bottom of trench is disturbed, recompaction shall be required.

0.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A.** Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

0.7 EXCAVATION FOR UTILITY TRENCHES

- A.** Excavate trenches to indicated gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line unless otherwise noted.
- B.** Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
 - 1. Clearance: 12 inches each side of pipe or conduit.
- C.** Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 - 1. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade. If material remaining at bottom of trench is disturbed, recompaction shall be required.
 - 2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
 - 3. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

0.8 SUBGRADE INSPECTION

- A.** Notification Point - Notify Engineer when excavations have reached required subgrade.
- B.** If Engineer determines that unsatisfactory soil is present, continue excavation and replace with backfill with crushed stone wrapped with non-woven geotextile fabric.
- C.** Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with crushed stone wrapped with non-woven geotextile fabric.
- D.** Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

0.9 UNAUTHORIZED EXCAVATION

- A.** Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi may be used when approved by Engineer.
1. Fill unauthorized excavations under other construction or utility pipe with crushed stone wrapped with non-woven geotextile fabric as directed by Engineer.

0.10 STORAGE OF SOIL MATERIALS

- A.** Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

0.11 BACKFILL

- A.** Place and compact backfill in excavations promptly, but not before completing the following:
1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 2. Surveying locations of underground utilities for Record Documents.
 3. Testing and inspecting underground utilities.
 4. Removing concrete formwork.
 5. Removing trash and debris.
 6. Removing temporary shoring and bracing, and sheeting.
 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

- B.** Place backfill on subgrades free of mud, frost, snow, or ice.

0.12 UTILITY TRENCH BACKFILL

- A.** Place backfill on subgrades free of water, mud, frost, snow, or ice.
- B.** Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Sand borrow bedding shall be placed by hand shovels, in layers not more than 4-inches thick in loose depth, and each layer shall be thoroughly and evenly compacted by tamping on each side of the pipe to provide uniform support around the pipe, free from voids. Crushed stone bedding material shall be placed in layers not more than 6-inches thick in loose measure, and compacted with at least 4 passes using a vibratory plate or roller compactor.
- C.** Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 03300 - CAST-IN-PLACE CONCRETE.
- D.** Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.
- E.** Place and compact initial backfill of material free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- F.** Backfill voids with satisfactory soil while installing and removing shoring and bracing.
- G.** Place and compact final backfill of satisfactory soil to final subgrade elevation in uncompacted layers not to exceed 9 inches.
- H.** The Contractor shall not place backfill against or on structures until they have attained sufficient strength to support the loads (including construction loads) to which they will be subjected, without distortion, cracking or other damage. As soon as practicable after the structures are structurally adequate and other necessary work has been satisfactorily completed, the Contractor, as required by the Engineer, shall make special leakage tests of the structures. After the satisfactory completion of leakage tests and the satisfactory completion of any other required work in

connection with the structures, the backfilling around the structures shall proceed using Controlled Density Fill (CDF) material. Symmetrical backfill loading shall be maintained. Special care shall be taken to prevent any wedging action or eccentric loading upon or against the structures.

- I. Install warning tape directly above utilities, no less than 12 inches above the crown of the pipe or utility and no more than 16 inches above the crown of the pipe or utility.

0.13 EMBANKMENT FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
 - 2. Under walks and pavements, use satisfactory soil material.
 - 3. Under steps and ramps, use engineered fill.
 - 4. Under building slabs, use engineered fill.
 - 5. Under footings and foundations, use engineered fill.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

0.14 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

0.15 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent minimum; and areas within 10 feet of structures, building slabs, steps, and pavements at 95 percent minimum.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent minimum.
3. Under lawns, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent minimum.
4. Under unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent minimum.
5. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent minimum.
6. For embankments, compact each layer at minimum 92 percent minimum.

0.16 GRADING

- A.** General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
1. Provide a smooth transition between adjacent existing grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B.** Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
1. Lawn or Unpaved Areas: Plus or minus 1 inch.
 2. Walks: Plus or minus 1 inch.
 3. Pavements: Plus or minus 1/2 inch.
- C.** Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

0.17 SUBSURFACE DRAINAGE

- A.** Subdrainage Pipe: Specified in Section 02400 - DRAINAGE AND SEWER SYSTEMS.
- B.** Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase

subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 90 percent of maximum dry unit weight according to ASTM D 1557.
- C. Drainage Backfill:** Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with 1 layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
1. Compact each filter material layer to 90 percent of maximum dry unit weight according to ASTM D 1557.
 2. Place and compact impervious fill over drainage backfill in 6-inch-thick compacted layers to final subgrade.

0.18 SUBBASE COURSE

- A.** Place subbase course on subgrades free of water, mud, frost, snow, or ice.
- B.** On prepared subgrade, place subbase course under pavements and walks as follows:
1. Shape subbase course to required crown elevations and cross-slope grades.
 2. Place subbase 6 inches or less in compacted thickness in a single layer.
 3. Place subbase that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 4. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
- C. Pavement Shoulders:** Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

0.19 DRAINAGE COURSE

- A.** Place drainage course on subgrades free of water, mud, frost, snow or ice.
- B.** On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 90 percent of maximum dry unit weight according to ASTM D 1557.

0.20 FIELD QUALITY CONTROL

- A.** Testing Agency: The Contractor shall engage a qualified independent testing agency to perform field quality-control testing.
- B.** Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C.** Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.
- D.** An Independent Laboratory will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than 3 tests.
 2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.
 3. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet or less of trench length per lift, but no fewer than 2 tests.
- E.** When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained. Authority will conduct confirmatory testing.

0.21 PROTECTION

- A.** Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B.** Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they

lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.
- C.** Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

0.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A.** Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off the User Agency's property.

PART 4 - MEASUREMENT AND PAYMENT

0.1 MEASUREMENT

- A.** The following classifications of work will be measured by the cubic yard unless otherwise indicated:
1. Unclassified Excavation
 2. Structure Excavation
 3. Subway Excavation
 4. Roadway Excavation
 5. Rock Excavation, Class A and B
 6. Muck Excavation
 7. Borrow Excavation, including Ordinary Borrow, Gravel Borrow, Crushed Stone, Sand Borrow and Special Borrow.
 8. Embankment
 9. Structure Backfill
 10. Pervious Backfill
 11. Impervious Backfill
 12. Salvaging Topsoil
 13. Trench Excavation.
- B.** The following classifications of work will be measured by the square yard:
1. Fine Grading and Compacting
 2. Presplitting Rock

- C. Grading and Finishing will be measured as a lump sum for the entire Contract.
- D. Compacting original ground will not be measured separately for payment, but all costs in connection therewith will be considered incidental to the embankment to be constructed on the compacted original ground.
- E. Quantities of excavation and backfill will be determined from limits indicated or specified herein, or in the Construction Specifications, plus any additional excavation and backfill authorized or required by the Engineer not due to the Contractor's negligence. Where limits for excavation and backfill are not indicated, the quantities will be computed within the following limits:
1. The horizontal limits for computing pay quantities shall be vertical planes one foot outside the neat lines of footings or structures.
 2. The upper limit for payment for excavation shall be the ground surface as it existed prior to the start of construction operations. Where it is required that the excavation be made in new embankment, the upper limit shall be the planes of the new embankment at the elevation indicated or directed for construction in advance of performing the required excavation, but in no case shall the upper limit be above the planes of the new embankment.
 3. The upper limit for payment of backfill, when not indicated, shall be the ground line at the time the excavation is made; except, when backfill is ordered to a higher limit by the Engineer, limit for payment shall be the higher limit ordered.
 4. The lower limits for computing pay quantities of excavation and backfill shall be a plane at the bottom of the completed footings, structures or trench, unless excavation of unsuitable material is ordered to lower depth.
 5. Trench Excavation
 - a. General
 - 1) Unless otherwise specified, the cost of the initial five feet of excavation for drain lines, sewer pipes and water lines shall be included in the price of the pipe placed.
 - b. Class A trench excavation will be measured as follows:
 - 1) For masonry culverts, having a clear span of less than eight feet, inlets and walls, and utilities, the measurement shall be a width of one foot outside the base of the masonry sections indicated on the Contract Drawings and to the depth indicated or directed.
 - 2) Trench excavation for walls in cuts shall include only that portion below the elevation of the subgrade adjacent to the wall. For walls where an embankment is indicated, trench excavation shall be only that portion between the existing ground and the bottom of the foundation.
 - c. Class B trench excavation will be measured as follows:
 - 1) For pipe culverts, drains, and water pipes, the depth of excavation shall be from the bottom of the pipe barrel to the

bottom of previous excavation or existing ground, whichever is lower, as determined above the centerline of the pipe, less the initial five feet of excavation.

- 2) The width of excavation shall be three feet greater than the rated inside diameter of the pipe up to a point five feet above the bottom of the pipe barrel, and a width above that point equivalent to the base width plus an allowance for one to one slopes on the sides of the trench for the measured depth described above.
- 3) The allowance for one to one slopes will be included regardless of the actual slopes excavated or whether sheeting or shoring is used.
- 4) The sides of the trench excavation will be considered vertical when sheeting is used and paid for separately, as specified in the Construction Specifications, and the width shall be three feet greater than the inside diameter of the pipe.

- F.** Quantities of pervious and impervious backfill and borrow will be determined from the dimensions indicated or the dimensions authorized or required by the Engineer.
- G.** Excavation for the Contractor's convenience, unauthorized excavation outside the limits indicated and backfill of such excavations will not be measured for payment.
- H.** Re-excavation and rehandling of stockpiled material will not be separately measured for payment, but will be considered incidental to the earthwork to which it pertains.
- I.** Test Pits will be measured by the cubic yards of material excavated.
- J.** Unless otherwise indicated, grading, shaping, and compacting of that portion of excavations, backfills, embankments, and original ground, upon which pavement, ballast, subballast, Hot Mix Asphalt underlayment, or structures are to be placed, will be measured by the square yard.

0.2 PAYMENT

- A.** The unit price bid per cubic yard for excavation associated with Test Pits and for excavation of rock materials shall include all costs of excavating such material, including handling, on-site reuse, and off-site disposal, and furnishing all labor, materials, equipment, and incidentals necessary to satisfactorily complete the work. The unit price bid per cubic yard for Unclassified Excavation and Trench Excavation shall include the cost of excavating such material and any on-site reuse of such material as ordinary and gravel borrow, including placing and compaction, and furnishing all labor, materials, equipment and incidentals necessary to satisfactorily complete the work. The cost of all other handling, testing, and environmental categorization of all Unclassified Excavation and Trench

Excavation soil materials and off-site transport and disposal of surplus, unsuitable, or contaminated excavated soil materials is separately measured and paid for in accordance with the provisions of Section 02282.

- B.** Where the depth of Class A trench excavation is greater than eight feet, as indicated, excavation below eight feet will be paid for at a price equal to 1-1/2 times the cubic yard price bid for Class A trench excavation, except that no such adjustment will be allowed for excavation of open ditches exceeding eight feet in depth or for excavation required for slope protection regardless of depth.
- C.** The unit price bid per cubic yard for Ordinary Borrow, Gravel Borrow, Sand Borrow, Special Borrow, and Pervious Backfill shall include the cost of furnishing, placing and compacting the subgrade and borrow material, including all labor, materials, equipment and incidentals necessary to satisfactorily complete the work.

0.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0222.003	UNCLASSIFIED EXCAVATION	CY
0222.103	ROCK EXCAVATION - CLASS A	CY
0222.151	TRENCH EXCAVATION - CLASS B	CY
0222.342	UNIT SUBSTATION EARTH EXCAVATION	CY
0222.442	TEST PITS	CY
0222.494	PERVIOUS BACKFILL	CY
0222.498	SAND BORROW	CY
0222.501	ORDINARY BORROW	CY
0222.504	GRAVEL BORROW	CY
0222.628	CRUSHED STONE	CY

END OF SECTION

NOTES TO THE DESIGNER

- A.** Any request to modify or waive the specification requirements listed below must be approved in writing from the MBTA Assistant General Manager for Design and Construction:
1. For soil compaction, the minimum 95% of Modified Proctor for roadways and trenches, and the minimum 92% of Modified Proctor for embankments shall not be changed.